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OPERATION ON A "DRY" HEART (FROM MATERIAL OF THE
11th SCIENTIFIC SESSION OF THE INSTITUTE OF
SURGERY IMENI A. V. VISHNEVSKIY OF THE
ACADEMY OF MEDICAL SCIENCES USSR)

By M. N. Arshinova
and
V. I. Burakovskiy

- USSR -

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OPERATION ON A "DRY" HEART (FROM MATERIAL OF THE
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Following is the translation of an article by
M.N. Arshinova and V.I. Burakovskiy entitled
"Operatsii na 'Sukhom' Serdtse (po materialam
11-y Nauchnoy Sessii Instituta Khirurgii imeni
A.V. Vishnevskiy AMN SSSR)" (English version
above), in Vestnik Meditsinskikh Nauk SSSR
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One of the current problems of modern thoracic surgery is the mastering of methods making it possible to operate under direct vision on the valves and septa of the heart.

Two methods permit the surgeon to perform operations on the "dry" heart: exclusion of the heart from the circulation under hypothermia and artificial circulation.

Both of these methods have been developed only in recent years. We need only cite as an example the fact that the first successful operation was performed under hypothermia by Lewis and Tauffiy in 1952 on a heart excluded from circulation, and up to the present time descriptions of scarcely more than 550 to 600 operations have been published in the international literature.

In spite of the complexity of the problem, the prospect, so enticing to the surgeon, of performing operations inside the heart under direct visual control has attracted the attention of many researchers and cardiologists.

In recent years many leading clinics in our country have been studying the methods making possible operations on a "dry" heart, (A.N. Bakulev, A.A. Vishnevskiy, P.A. Kupriyanov, S.A. Kolesnikov, Ye. N. Meshalkin, B.V. Petrovskiy, A.G. Savinykh, F.G. Uglov, etc.)

In January 1957 Surgical Institute imeni A.V. Vishnevskiy of the Acad Med Sci USSR began work on the complex problem of surgery on the "dry" heart.

In 1957 for the first time in our country Professor A.A. Vishnevskiy performed successful operations under direct vision on patients with congenital heart disease. These operations were performed with the first domestic apparatus for artificial circulation (designed by the Scientific Institute for Experimental Surgical Apparatus and Instruments) as well as under hypothermia without this apparatus.

At the present time the work on the problem of surgery on the "dry" heart is being conducted jointly -- by surgeons, physiologists, hematologists, biochemists, pathologists, and pediatricians. Considerable work in devising domestic apparatus for artificial circulation is being conducted by the engineers and designers of the Scientific Institute for Experimental Surgical Apparatus and Instruments, in close cooperation with surgeon-cardiologists.

It should be noted that Soviet surgeons have achieved certain success in developing methods for operating on the "dry" heart. Nevertheless, many parts of this complex problem still remain unsolved. That is why the Institute of Surgery imeni A.A. Vishnevskiy, A.M.S., USSR, has deemed it necessary to devote its 11th scientific session to a broad discussion of the experience of operations on a "dry" heart, accumulated between 1957 and 1959, experimentally as well as clinically.

The session took place on 12 and 13 November 1959, attracting the attention of a large number of surgeons (the session was attended by over 400 surgeons from various cities of the Soviet Union). Participating in the session were the Minister of Health USSR, S.V. Kurashov, the President of the AMS, USSR, A.A. Bakulev, active member of the AMS USSR, Professor P.A. Kupriyanov, Professor S.A. Kolesnikov, A.A. Bussalov, B.A. Petrov, D.A. Arapov, and many others. The session took place under the chairmanship of active member of the AMS, USSR, Professor P.A. Kupriyanov, who was the first in this country to work on the problem of hypothermia and cardiac surgery.

During the session 11 reports were given, reflecting the experience of the Institute of Surgery imeni A.A. Vishnevskiy, in "dry" heart surgery both experimentally and clinically.

The report of Professor A.A. Vishnevskiy and of the candidate of medical sciences, V.I. Burakovskiy summarized the accumulated clinical experience on operations under hypothermia with exclusion of the heart from the circulation (this report will be published in one of the coming issues of the journal "Vestnik Akademii Meditsinskikh Nauk SSSR").

In this Institute a total of 24 operations were performed on patients with various congenital anomalies of the heart.

At the present time it is not recommended to cool the patients to temperatures below 31-28 degrees. The lowering of the temperature below 28-27 degrees is undesirable and may cause a number of serious and even fatal complications, mainly cardiac. Cooling of the patient to 31-28 degrees makes it possible to exclude the heart from the circulation for not more than eight to 10 minutes. This is the reason that the indication for the use of the method excluding the heart from circulation under hypothermia is so limited.

The authors believe that this method is indicated in patients with interatrial septal defects of the ostium secundum type and also in isolated valvular stenosis of the pulmonary artery and the aorta. Of 24 operated patients, nine died. It should be noted that in most of these cases fatal complications developed because the operations were based on inadequate indications and also because developmental anomalies discovered during the operation were not the kind that could have been corrected within seven to 10 minutes (common atrium, a defect of the type ostium primum).

In the so-called "blue" patients who suffer from prolonged hypothermia, the method of excluding the heart from the circulation is contraindicated. In such patients cerebral hemorrhages and thrombosis of the cerebral vessels easily develop. Two patients who suffered from marked hypothermia preoperatively were operated upon in the Institute and died on the second postoperative day from cerebral hemorrhage.

Reviewing the operative technique, the lecturers noted that the wide approach through both pleurae and transverse sternotomy was used in 22 operations. However, such an approach is extremely traumatic and may cause dangerous pulmonary complications in the postoperative period.

The transsternal approach with longitudinal splitting of the sternum, used by the authors on two patients with stenosis of the valves of the aorta and the pulmonary artery, proved considerably less traumatic than a bilateral thoracotomy; it can be recommended for operations on the "dry" heart., especially in small children.

In their report, A.A. Vishnevskiy and V.I. Burakovskiy described in detail the technique of operations on the "dry" heart.

Study of the pathological physiology of respiration and circulation made it possible to establish that with proper anesthesia and scrupulous adherence to operative technique there are, as a rule, relatively small changes in pulse, arterial pressure, electrocardiogram, and blood oxygen saturation, prior to the cardiac by-pass.

Considerable deviations from the normal gaseous exchange and circulation are observed during the period of exclusion of the heart from the circulation. However, if the period of the exclusion of the heart does not exceed eight minutes the respiratory and circulatory data revert to the original values in all operations.

The authors note the importance of the proper follow-up of patients in the postoperative period. Provisions for pain-free respiratory excursions and adequate tracheobronchial toilet are the basic prophylactic measures in preventing pulmonary complications in the majority of patients.

In their conclusions the authors pointed out that the method of exclusion of the heart from the circulation is less traumatic for the patient than artificial circulation and that with time it will be more widely used in clinical practice.

The problem of anesthesia for operations on a heart excluded from circulation is still far from being solved. As Professor P.A. Kupriyanov justly remarked, the anesthesiologist is faced with the responsible task of controlling all the complicated functions of the organism, which is impossible without profound knowledge of the physiological processes occurring when the heart is excluded from circulation. T.M. Darbinyan, candidate of medical sciences has described in detail the method of anesthesia used in the Institute of Surgery imeni A.V. Vishnevskiy for operations on the "dry" heart under hypothermia.

The basic principles of this method are: 1) discontinuance of the use of neuroplegic drugs; 2) induction of hypothermia under superficial ether-oxygen anesthesia with fractionated administration of large doses of diplacin; 3) cooling in relatively warm water (+8,+10 degrees) of only 50 percent of the body surface; 4) lowering of the body temperature to 28-31 degrees.

Discontinuance of the use of neuroplegic drugs is dictated by the following reasons: at the end of the period of cardiac exclusion, after the clamps are taken off the vanae cavae, various forms of disturbances of cardiac function frequently take place, requiring immediate administration of vasoconstrictors and myocardial stimulants. The use of these drugs may prove ineffective in artificially produced neuroplegia and this may interfere to a considerable degree with the restoration of cardiac function.

Prior to anesthesia the patient is given pantopon with atropine: the induction of anesthesia is accomplished with thiopental sodium or nitrous oxide with ether. Various muscle relaxants (ditilin, curacit, diplacin, tubocurarin) facilitate intubation.

After entering the chest cavity it is imperative to introduce a 0.25 percent solution of novocaine under the pleura, in the area of the hilus of the lung and other reflexogenic zones, and also to block with one percent novocaine the Keith-Flack node, thus making it possible to block electively the afferent impulses from the thoracic cavity.

The speaker stressed the necessity of adequate ventilation of the lungs during the entire operation and of maintaining a certain level of arterial pressure until the moment of cardiac exclusion from the circulation. T.M. Darbinyan reported the interesting observation that after spontaneous restoration of cardiac function (i.e., without the administration of adrenalin) the patient developed hypertension in the greater circulation (150-160mm of mercury).

So considerable an increase in arterial pressure could bring about such complications as cerebral hemorrhage, failure of the seams of the aortic wall, etc. The mechanism of the hypertension is not yet clear. It is possible that an important role in the increased pressure is played by hypercannia and hypoxemia, which develop during the period of cardiac exclusion from the circulation. In order to prevent these occurrences the speaker suggests prolonging the period of hyperventilation of the lungs before cardiac exclusion from circulation while introducing large doses of curarelike drugs. Hypertension being evidenced, a carefully administered intravenous drip of arfonad solution is indicated.

One of the most dangerous complications developing during operations on the heart excluded from the circulation under hypothermia is cardiac arrest. The report of B.M. Tsukerman and A.A. Barskaya was devoted to this problem. In these operations surgeons encounter the following forms of cardiac arrest: a) acute myocardial weakness (cardiac arrest in diastole); b) ventricular fibrillation; c) decreased automaticity of the heart, especially as a result of strong inhibition of the vagal nerve.

During the operations these three forms of cardiac arrest are rarely observed as an isolated variety.

Very frequently, by the end of the period of cardiac exclusion from circulation, the myocardial tonus is considerably decreased. The electrocardiogram shows typical for myocardial hypoxia and indicating various types of disturbances of rhythm and conduction of stimuli. Attempts to restore the rhythmical contractions during this period frequently leads to the development of ventricular fibrillation. Ventricular fibrillation (the so-called "sluggish" fibrillation) that has developed against a background of markedly lowered myocardial tonus is one of the most dangerous complications.

In the battle against acute myocardial failure and "sluggish" ventricular fibrillation, it is necessary to eliminate the myocardial hypoxia and restore its tonus. For this purpose, the freeing of the great vessels must be followed by immediate cardiac massage, insuring adequate pulmonary ventilation with 40-60 percent oxygen as adrenalin is introduced into the coronary arteries. This is achieved by intraarterial injection of 0.5 - 0.1 percent adrenalin with 100-150 ml of blood or by injecting a physiological solution with one ml of 0.1 percent adrenalin by puncturing the ascending aorta.

Defibrillation should be started only when the myocardial tonus has been adequately restored. Otherwise, the arrest of fibrillation will not bring about restoration of effective cardiac contractions.

In the Institute of Surgery imeni A.V. Vishnevskiy of the Acad Med Sci USSR, the defibrillator of the N.L. Gurvich system is used for defibrillation; it makes it possible to apply directly to the heart a short-acting (0.01 second) discharge from a condensor with a voltage up to 6,000 volts. The voltage necessary for defibrillation in the majority of the patients ranged from 1500 to 2,000 volts. Attempts to defibrillate with lower voltages were unsuccessful. At the end of the period of cardiac exclusion from the circulation acute myocardial failure developed in eight out of 24 operated patients and was followed with "sluggish" ventricular fibrillation. In seven of these patients cardiac action could be restored by applying the above-mentioned measures and the operation could be terminated at a satisfactory level of arterial pressure.

A number of reports was devoted to the surgical treatment of particular types of congenital cardiac anomalies. V.I. Burakovskiy, candidate of medical sciences, described the clinical picture, diagnosis, and certain aspects of the surgical treatment of interatrial septal defects. He pointed out that in view of the various forms of the anatomic structure of the defects in the septum, they frequently cannot be corrected by means of the closed methods of Sondergard, Bailey, etc. Data in the literature attest to this.

Patients with interatrial septal defects can now be divided into five groups according to the degree of hemodynamic changes, pulmonary hypertension, and clinical-X-ray picture.

The speaker believes that patients of the first group should not be subjected to operations because they give no evidence of important hemodynamic disturbances and because the clinical and rentgenological picture is meager.

An operation is indicated in patients in the second, third and fourth group which exhibit considerable changes of hemodynamics, a pronounced clinical and X-ray picture of the anomaly, and increased pressure in the right ventricle and pulmonary artery.

The fifth group consists of patients with a marked sclerosis of the pulmonary vessels, high pressure in the pulmonary artery, and a changed shunt through the defect. Surgery is contraindicated in these patients.

The differential diagnosis between defects of the ostium primum and ostium secundum type is of great practical importance. The defects of the first type have to be operated on by the use of artificial circulation.

The development of operative technique is of great importance. In order to avoid air embolism during cardiac exclusion from the circulation, it is necessary to clamp the aorta so as to compress the ostium of the coronary vessels. The air from the cardiac cavities is expelled by blood from the superior vena cava and to accomplish this, the tourniquet clamping the vein is loosened before the termination of the intracardiac stage of the operation.

The defect in the septum is closed with a continuous suture. If the defect is situated near the superior or inferior vena cava, the first suture should be applied so as to sew several stitches through the posterior wall of the vein. Such a use of the sutures makes it possible to avoid non-physiological drainage from the vein after closure of the septal defect.

After the operation the condition of the patients improves considerably, the size of the heart decreases, and pressure in the pulmonary artery and right ventricle becomes lower.

R.S. Vinitskaya's paper, "Hemodynamics in interatrial and interventricular defects" to a certain extent was a continuation of V.E. Burakovskiy's report.

A number of important practical conclusions were formed on the basis of considerable material and the use of all the most modern methods of investigation.

As a rule, in interatrial and interventricular septal defects the blood flow through the lesser circulation increases. In some patients the blood flow through the system of the pulmonary artery reaches huge figures (16-22 liters per minute). At the same time there is an increase in the minute volume of blood in the vessels of the greater circulation. Contrary to existing opinion, R.S. Vinitskaya noted that a moderate increase of pressure in the pulmonary artery takes place in the majority of cases as a result of increased blood flow and in spite of low vascular resistance. Increase

in peripheral resistance causes a considerable increase of pressure in the system of the lesser circulation and in the right ventricle.

Progressive increase in peripheral resistance due to sclerosis of the pulmonary vessels eventually causes a change in the direction of the shunt through the septal defect. In the early stages, the direction of the shunt through the defect can change only from physical exertion, whereas in the late stages of the disease the patients show considerable hypoxemia even at rest. Patients with a changed shunt (even in the early stages of the process) should not be operated upon.

The speaker rightfully concludes that an accurate evaluation of the hemodynamic conditions in the septal defects of the heart is necessary for the surgeon to determine the indications or contraindications for an operation and is of great importance in evaluating the effectiveness of surgical treatment.

Candidate of medical sciences, A.M. Kudryavtseva devoted her report to the surgical treatment of valvular stenosis of the pulmonary artery. She elaborated in detail on the difficulties in diagnosing this anomaly, on the methods making it possible to pinpoint the diagnosis and on indications for surgical treatment. The speaker recommends that operations for valvular stenosis of the pulmonary artery be performed as early as possible, before serious impairment of circulation has occurred.

There is no uniform opinion among surgeons as to which of the methods of valvulotomy is preferable: the closed, or under direct vision. Considering the possibility of various complications during closed valvulotomy (formation of a "false" duct from the right ventricle into the pulmonary artery, damaging of the wall of the pulmonary artery, etc), the speaker recommends an operation under direct vision by cardiac exclusion from the circulation under hypothermia, which makes it possible to correct the stenosis by dissecting the fibrous tissues precisely between the leaflets of the valve and up to the wall of the pulmonary artery, as well as to inspect the outlet from the right ventricle. The technique of the operation is described in detail in this report.

After the operation, the pressure in pulmonary artery increases to normal as it decreases in the right ventricle. The condition of the patient improves considerably.

The problems of surgical treatment of congenital aorta stenosis were expounded in the report of candidate of medical sciences A.S. Kharnas. This anomaly, a serious affliction, is found on the average in five to six percent of patients with congenital anomalies of the heart. Discussing the cli-

nical picture and diagnosis of this anomaly, the speaker pointed out the great value of left ventricular puncture and ventriculography in order to obtain accurate data of the degree of hemodynamic impairment, the enlargement of the left ventricle, and the poststenotic dilation of the aorta.

The problem of surgical treatment of congenital aortic stenosis has not yet been solved. In this anomaly closed methods of treatment cannot be used, as splitting the leaflets of the valves leads to aortic insufficiency, a no less serious anomaly. It is necessary to split the commissure precisely between the valves. This can be achieved only under direct vision.

The method of artificial circulation is more complicated than exclusion of the heart from circulation under hypothermia, and six to eight minutes is entirely adequate for the performance of the commissurotomy. Therefore it is advisable to use the latter method. Embolization of the coronary vessels should not be feared, as in an opened aorta the ostia are collapsed and no air penetrates it. During the intracardiac stage of the operation, the aorta is clamped at the point at which it leaves the pericardium. The correction of a subvalvular stenosis of the aorta is more complicated.

The speaker noted that arterial hypertension may develop in the first postoperative hours. Administration of arfonad by the drip method leads to normalization of the pressure and improvement of the general condition.

After the operation pulsation of the aorta improves and the work of the left ventricle becomes less intense. The ballistocardiogram indicates an increased ejection of blood into the aorta.

Special methods of investigation are of great importance in modern cardiology.

A. A. Akhmetov spoke of the value of left ventricular puncture in the diagnosis of aortic stenosis, and Yu. V. Volynskiy spoke of changes in the circulatory dynamics in interseptal defects of the heart studied by means of analysis of pressure curves taken during cardiac catheterization.

In stenosis of the aorta and pulmonary artery and hypertension in the lesser circulation, the pressure curves undergo typical changes, which are important to consider for a successful diagnosis of these anomalies. Left ventricular puncture and cardiac catheterization make it possible to determine the presence of a pressure gradient between the ventricle and the great vessels. These facts make it possible to form a judgment not only on the presence, but also the degree of stenosis.

Two reports were devoted to the problem of extracorporeal circulation.

Work on this complicated problem began relatively recently in the Soviet Union, whereas abroad, there has already been rather considerable experience in operations on the "dry" heart by means of various devices for artificial circulation.

The first Soviet apparatus for artificial circulation (AIK-1) was created in 1957 by the Scientific Research Institute for Experimental Apparatus and Instruments, and in the same year it was used in operations for certain congenital anomalies of the heart in clinics of the Institute of Surgery imeni A.V. Vishnevskiy.

However, further experimental and clinical tests of the AIK-1 in the Institute of Surgery imeni A.V. Vishnevskiy, and in several other cardiological hospitals (tests were conducted by the staffs of clinics together with co-workers of the SRIESA and I., the designers of the apparatus) showed that essential deficiencies were present in the work of the experimental model.

At the present time the apparatus has been considerably perfected. Detailed descriptions of the new model of the apparatus for artificial circulation were given in the report of M.G. Ananyev, Ye. A. Vaynrib, A.A. Vishnevskiy, Yu. G. Kozlov, L.A. Levitskaya, L.N. Martynov, S.A. Mushegyan, Ye.A. Frid.

In this apparatus the oxygenator was changed, the suction system for the venous blood was improved, a device for the suction of coronary blood was added, the hydrodynamic resistance of the apparatus was recalculated and some other changes were introduced.

The size of the oxygenator was almost doubled, making it possible to increase the effectiveness of the apparatus in use to five to six liters of blood per minute.

At the present time the perfected apparatus for artificial circulation is being tested in six cardiological clinics of the country, (A.A. Vishnevskiy, S.A. Kolesnikov, Ye. N. Meshalkin, B.V. Petrovskiy, F.G. Uglov, A.G. Savinykh).

Twenty-three experiments on dogs were conducted in the Institute of Surgery imeni A.V. Vishnevskiy under the direction of Professor A.A. Vishnevskiy and Professor L.L. Shik: eight experiments with the AIK-1 of the old design and 15 with the perfected apparatus.

Surgeons, physiologists, hematologists and biochemists participated in the experiments (report of A.S. Kharnas, Ye.A. Khrushcheva, Ye. A. Kolyaditskaya, R.S. Vinitetskaya, Yu. D. Volynskiy, T.N. Promtovaya, A. B. Pogosova, Yu. Ye. Babskaya).

Combined studies showed that during cardiac by-pass the newly constructed apparatus insures a constant arterial

pressure and good oxygen saturation of the blood and creates conditions necessary for adequate blood supply to the brain; the decrease in the alkaline reserve of the blood is less pronounced.

However, the new improvements have not yet fully solved the problem of artificial circulation.

Unsolved are some hematological problems, such as blood coagulation. The exact dosage of heparin and protamin sulfate presents some difficulties.

Analogous data were obtained in the Institute for Chest Surgery of the Acad Med Sci USSR. (from the remarks of S.M. Smirenskaya in the discussions).

Participating in the discussions were: Z.P. Zubarev (Moscow), M.V. Murav'yev (Moscow), M.B. Dolgopol (Moscow), V.M. Pokrovskiy (Krasnodar), Ye.M. Smirenskaya (Moscow).

In his concluding address, Professor P.A. Kupriyanov pointed out the urgency of the problems to which the 11th scientific session of the Institute of Surgery imeni A.V. Vishnevskiy was devoted. He emphasized that both the exclusion of the heart from the circulation under hypothermia, and extracorporeal circulation present a complicated biological problem, which can be solved only by comprehensive studies with the participation of physiologists, hematologists, pathologists, biochemists, and other specialists.

It is necessary to develop both methods permitting surgery on the "open" heart without pitting one against the other.

In speaking of indications for various methods of surgical treatment of cardiac anomalies, P.A. Kupriyanov expressed the hope that with time all corrective cardiac operations will be performed under direct vision.

In conclusion P.A. Kupriyanov congratulated the Institute of Surgery imeni A.V. Vishnevskiy of the A.M.S., USSR, on its achievements.

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